

CLAIMS

1. An electrode material for a lithium secondary battery, comprising particles of a solid state alloy having silicon as a main component, wherein the particles of the solid state alloy have a microcrystal or amorphous material comprising an element other than silicon, dispersed in microcrystalline silicon or amorphized silicon.
- 10 2. The electrode material for a lithium secondary battery according to claim 1, wherein the solid state alloy contains a pure metal or a solid solution.
- 15 3. The electrode material for a lithium secondary battery according to claim 1, wherein the alloy has an element composition in which the alloy is completely mixed in a melted liquid state.
- 20 4. The electrode material for a lithium secondary battery according to claim 1, wherein the alloy is composed of silicon and at least a first element A having a lower atomic ratio than silicon, and wherein the first element A is at least one element selected from the group consisting of tin, indium, gallium, copper, aluminum, silver, zinc and titanium.
- 25 5. The electrode material for a lithium secondary battery according to claim 1, wherein the

alloy is composed of silicon, at least a first element A and a second element E each having a lower atomic ratio than silicon; the atomic ratio of the first element A is higher than the atomic ratio of 5 the second element E; the first element A is at least one element selected from the group consisting of tin, aluminum and zinc; the second element E is at least one element selected from the group consisting of copper, silver, zinc, titanium, aluminum, vanadium, 10 yttrium, zirconium and boron; and the first element and the second element are different from each other (A≠E).

6. The electrode material for a lithium secondary battery according to claim 1, wherein the 15 alloy has a silicon content of 50 weight% or higher and 95 weight% or lower.

7. The electrode material for a lithium secondary battery according to claim 1, wherein the alloy contains a eutectic.

20 8. The electrode material for a lithium secondary battery according to claim 7, wherein the eutectic is selected from the group consisting of:

(a) a eutectic of silicon and a first element A, the first element A being at least one element 25 selected from the group consisting of tin, indium, gallium, copper, aluminum, silver, zinc and titanium; (b) a eutectic of silicon and a second element E,

the second element E being at least one element selected from the group consisting of copper, silver, zinc, titanium, aluminum, vanadium, yttrium, zirconium and boron;

5 (c) a eutectic of the first element A and the second element E, the first element and the second element being different from each other;

(d) a eutectic of any combination of (a), (b), and (c).

10 9. The electrode material for a lithium secondary battery according to claim 1, wherein the silicon in the alloy is doped with at least one element selected from the group consisting of boron, aluminum, gallium, antimony and phosphorous at a 15 dopant amount of an atomic ratio in a range of 1×10^{-8} to 2×10^{-1} with respect to the silicon.

10. An electrode material for a lithium secondary battery, comprising silicon particles having silicon as a main component, wherein the 20 silicon is doped with at least one element selected from the group consisting of boron, aluminum, gallium, antimony and phosphorous at a dopant amount of an atomic ratio in a range of 1×10^{-8} to 2×10^{-1} with respect to the silicon.

25 11. The electrode material for a lithium secondary battery according to claim 9 or 10, wherein the dopant has an atomic ratio in a range of 1×10^{-5}

to 1×10^{-1} with respect to the silicon.

12. The electrode material for a lithium secondary battery according to claim 9 or 10, wherein the dopant is boron.

5 13. The electrode material for a lithium secondary battery according to claim 1 or 10, wherein the particles of the alloy having silicon as a main component or the particles having silicon as a main component have an average particle diameter of 0.02
10 μm to 5 μm .

14. The electrode material for a lithium secondary battery according to claim 1 or 10, wherein the particles of the alloy having silicon as a main component or the particles having silicon as a main
15 component has a form of fine powder.

15. The electrode material for a lithium secondary battery according to claim 1 or 10, wherein the particles of the alloy having silicon as a main component or the particles having silicon as a main
20 component are complexed with at least a material selected from the group consisting of a carbonaceous material and metal magnesium.

16. An electrode structure comprising an electrode material according to claim 1 or 10, a
25 conductive auxiliary material, a binder and a current collector.

17. The electrode structure according to claim

16, wherein the conductive auxiliary material is a carbonaceous material.

18. A secondary battery comprising an electrolyte, a positive electrode and a negative 5 electrode using an electrode structure according to claim 16, wherein the secondary battery utilizes a lithium oxidation reaction and a lithium ion reduction reaction.

19. The secondary battery according to claim 18, 10 wherein a material of the positive electrode is a lithium-transition metal complex oxide comprising at least yttrium or yttrium and zirconium.